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# Diabetic patients' adequacy of knowledge related to insulin injecting techniques and practices. A cross-sectional study from Punjab, Pakistan

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## ABSTRACT

**Background:** Insulin therapy is considered a vital approach for the therapeutic management of insulin-dependent diabetes mellitus. Various insulin administration devices are available worldwide, among which self-administration devices are most commonly used. **Objective:** The present study evaluates the influence of a pharmacist-conducted educational intervention on the adequacy of knowledge related to insulin injecting techniques and practices among diabetic patients and its effect on their glycemic control. **Methods:** The current cross-sectional study recruited diabetic patients from Punjab, Pakistan. Blood glucose levels as fasting blood glucose (FBG) were recorded during the baseline survey. The knowledge and practices of insulin injection techniques were accessed through the "Injection Technique Questionnaire". Pharmacists provided educational intervention to patients regarding self-administration techniques of insulin. Post-intervention evaluation was conducted with a gap of 3 months. **Results:** Among 177 adult diabetic patients, the majority of the patients were not presenting adequate injecting techniques and practices at baseline. However, as a result of educational intervention, the injection administration practices presented statistically significant improvement ( $p < 0.05$ ) as presented through Stuart-Maxwell testing. There was a significant difference  $p < 0.05$  on the scores of pre FBG ( $M = 195.34$ ,  $SD = 47.32$ ) and post FBG ( $M = 175.16$ ,  $SD = 33.67$ );  $t(176) = 9.95$  among diabetic patients. **Conclusion:** Pharmacist-led educational intervention substantially improved the knowledge and practices of the patient's injection technique.

**Keywords:** Diabetes Mellitus; Educational intervention; Insulin therapy; Insulin Injecting techniques; Injection Technique Questionnaire; Fasting blood glucose (FBG).

## 1. INTRODUCTION

For diabetic patients, it is very important to maintain their lifestyle in a good way that is, by taking a simple and healthy diet, weight control, exercise and monitored blood glucose level by self (Shera et al., 2017). Proper insulin injection practice is extremely important for desirable diabetic control (Poudel et al., 2017). Insulin therapy is one of the approaches for diabetes management. Insulin treatment is vital for both type 1 and type 2 diabetic patients who become insulin dependent (Benson and Faff, 2004). Poor technique is not only related to the increased insulin dose but also leads to the variation in glucose level. Moreover, improper disposal of sharps is hazardous for people around them (Frid et al., 2016). Most of the insulin-treated patients are still ignorant about the importance of appropriate injection techniques (IT).

The incorrect choice of injection site may lead to variation in absorption or a couple of problems and this may cause hyper or hypoglycemia (Strauss et al., 2002). Physicians meet up with the insulin-administered patients and guide them about different issues like how to adjust doses and how glucose levels can be maintained within range, but no one gives proper attention to insulin administration. Most of the patients are also unaware about the significance of technique, but now in recent years the importance of insulin injection practice is highlighted (Strauss et al., 2002; Grassi et al., 2014). Most of the patients practice their own IT, which may not be according to recommendations. It was also observed that majority of patients were not following the standard technique so regular assessment and continuous education of insulin injection technique (IIT) is very important to overcome the IT related issues (Strauss et al., 2002).

A very large survey was conducted in 42 countries, which also reported that diabetic patients had poor insulin injection practices (Frid et al., 2016). Studies related to the adjacent countries like China and India also exhibit the noteworthy difference between injection practice and guidelines (Ji and Lou, 2014; Kalra et al., 2017). Educational intervention is proved to be highly beneficial for improving clinical outcomes of various diseases (Iqbal et al., 2014; Shahid et al., 2022a). Since pharmacists are the last healthcare providers in the chain to see patients before the drug or insulin device is dispensed, therefore they are ideally positioned to guide the patients regarding proper technique of device usage (Shahid et al., 2022b).

Government should take steps to make specialized institutions where patients should be properly trained and guided regarding their disease conditions; DMTAC clinics are operating in Malaysia, where pharmacists provide their services in patient education and contribute their part in disease burden control (Iqbal et al., 2021). The present study was designed with the objective of assessing the diabetic patient's inadequate knowledge of insulin injection techniques. Moreover, the effect of pharmacist led educational intervention upon patient's fasting blood glucose level was also observed.

## 2. MATERIALS AND METHODS

### Study Approval

A prospective interventional study was conducted upon the Diabetes Mellitus patients from diabetic center of the Tehsil headquarter hospital, Chak Jhumra, Faisalabad, Pakistan. The Ethical Review Board (ERB) of hospital, had also approved this study to be conducted in their premises with a protocol reference; Ref. No. 228/HR/THQH/CKJ. Due to the location in central Punjab, this hospital has increased patient load which contributed to its selection for this study. The study duration was of 1 year that included baseline survey, provision of intervention and post intervention survey. Moreover, there was no considerable risk identified to study subjects, hospital staff or to the researchers.

### Inclusion & exclusion criteria

Insulin dependant diabetes mellitus (IDDM) patients with age greater than 18 years, currently administering insulin with syringe and willing to participate in this research project were included in this study. However, patients using diabetic pen and other devices for insulin administration were eliminated from this study. Patients who were on insulin injection therapy for the period of less than 6 months were excluded from the current study.

Data collection method

Originally, a total of 220 ambulatory patients were enrolled for the present study through convenient sampling technique method. However, due to some unknown reasons, a few patients were dropped out. As the result, 177 patients were included in the study which met the inclusion criteria. The questionnaire used in this study was “Injection Technique Questionnaire” Strauss et al., (2002) after formal permission from the corresponding author through email. The principal investigator provided educational intervention to patient individually, according to the “Forum for Injection Technique and Therapy Expert Recommendations” (FITTER) guidelines.

The intervention included theoretical education along with practical guidance with placebo device to patients individually. Brochures with literature designed according to FITTER guidelines, containing insulin injection technique instructions (in English & native language i.e., Urdu) along with related infographic, were distributed among study subjects. The education intervention contained all instructions related to preparation and administration of insulin. Afterwards, with the gap of 3 months, patient’s knowledge and current way of insulin administration were reassessed.

Ethical Considerations

Informed consent from the study subjects was acquainted before recruiting them for this study. The consent for participation was obtained after providing them the written information along with the verbal explanation of the study. The data of study subjects was strictly kept confidential as per the research ethics.

Statistical analysis

The collected data was analyzed by using Statistical Package for Social Sciences program software (SPSS version 21.0). Stuart-Maxwell test was used to measure the of pre and post variables. *p-value* <0.05 was considered as statistically significant.

3. RESULTS

Demographic Characteristics of Study Subjects

Table 1 demonstrates the demographic characteristics of diabetic patients included in the present study. A total of 177 diabetic patients were recruited for this study. Majority of the patients (67.2%) were female with age group ranging from 35-60 years and having type-2 Diabetes (92.7%). Table 2 presents the effect of educational intervention on MDI technique of patients before and after the provision of intervention.

Table 1 Demographic data of patients

Variables	Categories	Frequency (N)	Percentage (%)
Gender	Male	58	32.8%
	Female	119	67.2%
Age	18-24 years	10	5.6
	35-60 years	105	59.3
	60 and above	62	35
BMI	Underweight	2	1.1
	Normal	96	54.2
	Overweight	49	27.7
	Obese	30	17
Education status	Primary education	100	56.5
	Graduation & above	77	43.5
Type of Diabetes	Type 1 Diabetes Mellitus	13	7.3
	Type 2 Diabetes Mellitus	164	92.7
Family history	Yes	135	76.3
	No	42	23.7

Treatment of Diabetes	Insulin	140	79.1
	Insulin + Tablets	37	20.9
Administration of insulin	Self-administration	114	64.4
	Administration by others	63	35.6
Source of information	Diabetes specialist	27	15.3
	General Physician	82	46.3
	Pharmacist	1	0.6
	Nurses	9	5.1
	Others	58	32.8

**Table 2** Adequacy of knowledge and desire for more knowledge

Parameters	Pre-intervention (n=177)	Post-intervention (n=177)	P-value
	N (%)	N (%)	
Injection sites knowledge			< 0.001
Yes	4 (2.3)	176 (99.4)	-
Still need more training	173 (97.7)	1 (0.6)	-
Appropriate depth of injection			< 0.001
Yes	2 (1.1)	176 (99.4)	-
Still need more training	175 (98.9)	1 (0.6)	-
Length of needle			< 0.001
Yes	4 (2.3)	176 (99.4)	-
Still need more training	173 (97.7)	1 (0.6)	-
How to do a skin lift or pinch up			< 0.001
Yes	8 (4.5)	176 (99.4)	-
Still need more training	169 (95.5)	1 (0.6)	-
How long to hold a skin lift			< 0.001
Yes	9 (5.1)	176 (99.4)	-
Still need more training	168 (94.9)	1 (0.6)	-
Angle of needle entry			< 0.001
Yes	46 (26)	176 (99.4)	-
Still need more training	131 (74)	1 (0.6)	-
How long to keep the needle in the skin after injection			< 0.001
Yes	0	176 (99.4)	-
Still need more training	177 (100)	1 (0.6)	-
Rotation within an injection site			< 0.001
Yes	4 (2.3)	176 (99.4)	-
Still need more training	173 (97.7)	1 (0.6)	-
Prevention of air bubbles			< 0.001
Yes	2 (1.1)	176 (99.4)	-
Still need more training	175 (98.9)	1 (0.6)	-
Re-suspension of cloudy insulin			< 0.001
Yes	10 (5.6)	176 (99.4)	-
Still need more training	167 (94.4)	1 (0.6)	-
Single use of syringe			< 0.001

Yes	7 (4)	176 (99.4)	-
Still need more training	170 (96)	1 (0.6)	-
Safe disposal of sharps			< 0.001
Yes	7 (4)	176 (99.4)	-
Still need more training	170 (96)	1 (0.6)	-

Stuart-Maxwell test

Effect on Glycemic Control

There was a significant difference  $p<0.05$  on the scores of HbA1c level for pre HbA1c ( $M=9.85$ ,  $SD=0.91$ ) and post HbA1c ( $M=9.18$ ,  $SD=0.91$ );  $t(176)=35.92$ . There was as much as 0.67% decline in mean HbA1c level within 3 months duration.

Table 3 Impact on FBG Level before and after educational intervention

		FBG (mg/dl)				
		Pre-education	Post-education			
FBG (mg/dl)	n	M ± SD	M ±SD	T	df	P-value
	177	195.34 ±47.32	175.16 ±33.67	9.95	176	< 0.001

FBG Fasting blood glucose paired t test

There was a significant difference  $p<0.05$  on the scores of pre FBG ( $M=195.34$ ,  $SD=47.32$ ) and post FBG ( $M=175.16$ ,  $SD=33.67$ );  $t(176)=9.95$  among diabetic patients as shown in (Table 3).

4. DISCUSSION

The introduction of insulin therapy for management of Diabetes Mellitus was a major innovation in the field of medical sciences. Proper insulin injection practice is extremely important for desirable diabetic control. Poor technique is not only related to the increased insulin dose but also leads to the variation in glucose level. The present study focused on the adequacy of knowledge of diabetic patients regarding insulin injecting technique as well as the effect of pharmacist intervention on glycemic control of patients. The present study recruited a total of 177 diabetic patients from different areas of Punjab, Pakistan. Majority of the patients were type-2 diabetic females, belong to the age group of 35-60 years (Table 1).

Table 1 further shows that the source of instruction related to IT. 46.3% patients claimed that general physician instruct them about IIT, 15.3% said diabetes specialist told them about IIT. 5.1% were having instructing from general nurse, 0.6% from pharmacist and 32.8% instructed from others which include family members, neighbours or dispensers. Table 1 further shows that the distribution of sample population according to the last duration they received instructions on insulin administration technique. 58.8% said that they got instructions more than 12 months ago, 27.1% said they never received any instructions, 12.4% said they taught about instructions within past 6-12 months, 1.7% patients within past 6 months and not even single patient was instructed at every visit.

Patients were asked that which key aspects were covered when they were taught about IT or they need more training related to these aspects then patients give different responses which are following. When participants were asked that they had appropriate knowledge regarding injection sites or not then 97.7% said that they didn't have knowledge and need trainings. It showed significant result  $p<0.05$  after education because 99.4% patients said that now they had knowledge about injection sites. At baseline when patients were asked about appropriate depth 98.9% said that they didn't have knowledge about it and need more training and after education 99.4% had knowledge about this aspect and represent significant difference  $p<0.05$ .

Patients didn't know about different and appropriate length of needles 97.7% said that they need training and after education 99.4% said that they had knowledge regarding this and it represents significant result  $p<0.05$ . 95.5% subjects didn't know how to hold the skin. After education 99.4% said that had knowledge about this and also showed significant difference  $p<0.05$ . 94.9% sample population said that they didn't know how long to hold the skin and after education 99.4% said that they were taught about this step and showed

significant result  $p < 0.05$ . There was a significant difference  $p < 0.05$  between pre and post scores about angle of injection. 74% patients reported that they never taught about angle of injection while after education 99.4% said that they never taught about IT. No patients were taught about dwelling time of needle, after education 99.4% claimed that they were taught about this factor.

Rotation of injection site is very important to avoid complications, before education 97.7% patients said that they need more training and were never taught about this parameter while after education 99.4% said they were taught about it. 94.4% participants claimed that they were never taught about the correct way of remixing of insulin and after education majority of patients said that they were taught about mixing of cloudy insulin. 96% patients were not aware of not to reuse of single needle, after education 99.4% said that they had knowledge about this and need no more training on this. Majority of sample population 96% reported that they were not taught about how to dispose sharps but after intervention 99.4% said that they had knowledge about this and need no more training.

All those parameters related to the education of patients showed significant difference  $p < 0.05$  before and after education. In present study we found that before education patients didn't have knowledge related to proper remixing of insulin. Patients vigorously shake the insulin and they didn't have knowledge about how to mix it. Only 19.2% patients had proper knowledge about resuspension of insulin by roll or tip. After education all the sample population resuspended the insulin by rolling and tipping. The result was significant which was similar to the study performed in Iran. This study also showed significant difference  $p < 0.05$  after educational intervention. Before education 18.8% mixed insulin by rolling while after education 57.3% roll to resuspended insulin (Forough and Esfahani, 2017).

Another study was conducted in Malaysia related to the education of diabetic patients which showed that rolling technique was properly performed by 50.9% patients and 49.1% didn't do it properly. After education the percentage of correct step was increased up to 91.2% and inappropriate rolling step was reduced to 8.8%. So, results showed that education and training is necessary to overcome the insulin administration errors (Ahmad et al., 2016). There was a significant difference  $p < 0.05$  on the scores of pre FBG ( $M=195.34$ ,  $SD=47.32$ ) and post FBG ( $M=175.16$ ,  $SD=33.67$ );  $t(176) = 9.95$  among diabetic patients as shown in (Table 3). In IIT survey, 70% population claimed that they need more education and training related to IT from 1999-2000 while reduction appears in 2008-2009, 25% participants said that they need more knowledge (De-Coninck et al., 2010).

In the present study majority of participants desire more knowledge. Participants were educated after three months when they were asked about desire of more knowledge and training. All said they received education related to all aspects of IIT and need no more training. A survey performed in china represented that 51.58% patient's desire more knowledge related to IIT (Ji and Lou, 2014). Similarly, a randomized clinical trial conducted upon Malay population presented that pharmacist led educational intervention proved to be highly effective in glycemic control of the diabetic type-2 patients (Iqbal et al., 2024). Comparing the FBG (mg/dl) of sample population before and after education related to IIT represented the significant difference. Results of previous studies also investigated that FBG (mg/dl) show decline from pre to post values.

The controlled rate of FBG value was significantly improved from 45% to 63.9%. The improvement was due to education provided to patients (Forough and Esfahani, 2017). Initial education related to IIT reduced the error and significance of correct steps increased. A study was conducted to evaluate the effect of education by pharmacist and nurses on IIT and it showed that pharmacist intervention reduced the errors (Mitchell et al., 2012). Similarly, another cross-sectional study presented the results of reduction in lipid profile of diabetic patients in response to the educational intervention provided by pharmacists (Iqbal et al., 2021).

## 5. CONCLUSION

Majority of diabetic patients presented poor insulin injecting techniques during baseline survey. By focused education and training of patients insulin injecting techniques can be improved as concluded through this study. Pharmacist can play an important role in safe and efficient use of IIT by minimizing the errors associated with it which leads to better therapy adherence, decreases the local skin complication, increases knowledge of patients and also improves glucose control i.e., reduction in FBG (mg/dl) was also observed.

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### Author Contributions

This work was carried out in collaboration among all authors. Authors AB, SS, MA designed the study, performed the initial statistical analyses and wrote the protocol. Authors AB, AS, IA, MM and MF collected the data. Authors AB, MA and SMUL wrote the first draft of the manuscript. Authors MZI and SS managed refined analyses. Authors AB, FA and SS revised the manuscript. All authors read and approved the final manuscript.

### Ethical approval

The study protocol was approved by the Medical Ethics Committee of Quaid-i-Azam University Islamabad with the protocol number (BEC-FBS-QAU2018-99).

### Informed consent

Written & Oral informed consent was obtained from all individual participants included in the study. Additional informed consent was obtained from all individual participants for whom identifying information is included in this manuscript.

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This study has not received any external funding.

### Conflict of interest

The authors declare that there is no conflict of interests.

### Data and materials availability

All data sets collected during this study are available upon reasonable request from the corresponding author.

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